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ABSTRACT

Few studies have approached second language teaching from a neurolinguistic perspective. An exception is Marcel Danesi's educational construct of neurological bimodality, an attempt to find a neurological foundation for classroom language instruction. The underlying hypothesis is that there is a natural flow of information processing from the right to the left hemispheres of the brain during language learning; therefore, language instruction should reflect that flow direction by providing concrete forms of instruction at early language learning stages and more formal and abstract instruction at later stages. However, the hypothesis raises questions; for example, the evidence for right-hemisphere functions in second language learning is contradictory, yet those functions are an important element in bimodality. In addition, there have been few empirical studies supporting the hypothesis. (Contains 27 references.) (Author/MSE)

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Neurolinguistic Applications to SLA Classroom Instruction: A Review of the Issues with a Focus on Danesi's Bimodality

E. G. KIM-RIVERA

Few studies have approached second language teaching from the perspective of neurolinguistics. An exception is Danesi's educational construct called bimodality. Bimodality is an attempt to provide a neurolinguistic foundation for language instruction in the classroom. The underlying hypothesis is that there is a natural flow of information processing from the right to the left hemisphere of the brain during language learning; therefore, language instruction should reflect that flow direction by providing concrete forms of instruction at early stages and more formal and abstract instructions at later stages. This hypothesis, however, raises questions. For example, the evidence for right-hemisphere functions in second language acquisition (SLA) is contradictory; yet, those functions are an important aspect of bimodality. Moreover, there have been few empirical studies supporting the hypothesis.

INTRODUCTION

Since the efficacy of language teaching methodology came under fire in the 1970's (Danesi, 1987) there has been a general lack of agreement among researchers on how a second language is best acquired. Perhaps this uncertainty is why a growing number of researchers are looking to neuroscience for an answer to the fundamental question of second language acquisition (SLA). In spite of the growing interest in neuroscience, however, only a few studies of SLA in classroom settings have taken a neurolinguistic perspective. In particular, few researchers have applied neurolinguistic discoveries to the development of concrete propositions that could guide second language teachers. A notable exception is Marcel Danesi, who has developed an educational construct for the classroom based on neurolinguistic principles. This construct is called bimodality.

This article is a discussion of Danesi's bimodality and its implications to classroom teaching practices. As an introduction, however, the article first reviews a selection of studies in neuroscience over the last fifteen years that seem to have particular relevance to SLA research and that help define the possible role of neurolinguistics in language pedagogy. Finally, the article takes a special look at Danesi's bimodality construct and its issues.

REVIEW OF NEUROLINGUISTIC ISSUES

For the last two centuries, neurophysiologists have believed, according to clinical data on brain-damaged people, that each hemisphere of the brain has distinct, specialized functions (Danesi, 1987, 1990). It was known, for in

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speech impairment known as aphasia. Moreover, in 1861, Pierre-Paul Broca, in a case study of a patient with a brain lesion, discovered a connection between speech ability and the lateral left frontal lobe of the brain. In 1874 Carl Wernicke found a site in the left hemisphere related to speech comprehension. These observations gave credence to the idea that, for controlling language functions, the left hemisphere was superior to the right. More generally, the left hemisphere was considered the major, or dominant, half of the brain, probably because society placed more value on the skills it controlled, such as mathematics and grammar. The functions of the right hemisphere, meanwhile, were considered less important. Then, in the first half of the twentieth century, neuroscientific studies began to focus on what has come to be called the "localization" theory, that is, the belief that specific mental functions are controlled at specific locations in the brain.

More recent years have shown, however, that the hemispheres work cooperatively; that is, both sides of the brain are actively involved in higher cognitive processing. In the 1960s, for example, Roger Sperry and his associates (see Danesi, 1990), after a series of experiments on split-brain patients (individuals whose brain hemispheres were separated by surgical section of the corpus callosum), presented evidence that the activities of the two hemispheres were complementary and operated as a unit during higher cognitive processing, most noticeably in language processing. Their findings led to a spate of research in the 1960's and 1970's that challenged the notion of left-hemisphere dominance.

The following paragraphs summarize some of the major research neurolinguistic issues in the literature since the 1980s, with particular attention given to those that relate to the teaching and learning of a second language. These issues can be categorized as follows: brain lateralization and the organization of language functions, age and sex factors, neuronal involvement in first and second language acquisition, lateralization versus modularity, and the critical period and lateralization.

Brain Lateralization and Organization of Language Functions

A great deal of research has focused on brain lateralization and the organization of language functions. For example, in their 1981 study, Goldberg and Costa examined evidence for neuroanatomical differences of the cerebral hemispheres and their possible effects on cognitive processing. They hypothesized that the left hemisphere is superior in using multiple descriptive systems that are already available in the cognitive faculties, while the right hemisphere plays an important role in processing materials for which there are no pre-existing descriptive systems. According to this postulation, control of the requisite cognitive functions shifts from the right to the left hemisphere during processing. Thus, different hemispheres are involved in different stages of cognitive processing, so that neither hemisphere has exclusive control over particular cognitive tasks.

In the early 1970s, neuroscientists started to discuss the possibility of the involvement of the right hemisphere in language, and in the early 1980s the notion that the RH plays an important role in processing new stimuli became a workable hypothesis (Danesi, 1994). Albert and Obler observed in 1978 that language organization is more bilateral in bilingual children than in monolingual children, and that the RH is crucial in SLA. Other researchers, such as Arbib, Caplan, and Marshall (1982) and Segalowitz (1983), concluded that the right hemisphere is involved in the processing of prosodic, figurative language, and verbal humor, while the left hemisphere is engaged in processing discrete components of language. The right hemisphere is responsible for synthesizing these components into meaningful discourse.

In 1977, Hamers and Lambert argued that the role of the RH may be more active in adults than in children. In addition, Galloway and Krashen (1980), among others, put forward a "stage hypothesis" that postulated the dominance of the right hemisphere in initial stages of SLA and the dominance of the left hemisphere in later stages.

The most recent research in the involvement of the right hemisphere in language processing is inconclusive and ambiguous. It has shown, for example, that the two hemispheres actually share the traits normally assigned to them individually; that is, the left hemisphere is engaged in "holistic, parallel processing" and the right hemisphere in "analytical, serial processing" (Danesi, 1994, p. 220). There is, however, general agreement that the right hemisphere is important for processing word meaning.

Danesi concludes that there is no clear evidence that the right hemisphere is involved in SLA in any distinct manner and that caution must be exercised when formulating models of SLA based on right-hemisphere involvement at different acquisition stages and applying such models to second language teaching.

Furthermore, Paradis (1990) argued that the right hemisphere might actually interfere with the acquisition of native-like proficiency, since the greater the amount of proficiency achieved, the more asymmetrical are the results. Early language development entails bilateral involvement, but later the less efficient systems of the right hemisphere drop out of language processing. Paradis suggested, therefore, that the early use of the left hemisphere would improve the efficiency of SLA. In addition, he advised language teachers to use caution when applying "hypothetical and often quite controversial" (p. 582) neuropsychological constructs to their pedagogy.

In another study of lateralization, Anderson, Plunkett, and Hammond (1985) observed that the left hemisphere was responsible for essential language functions such as phonology, syntax, and semantics. Patients whose right hemisphere was damaged had difficulty comprehending a sentence in a larger context and registering inferences. Anderson et al. showed clear evidence that the right hemisphere supports intonation, musical abilities, evalua-

tion of the emotional tone of speech, and an appreciation of humor.

Anderson et al. further suggested that both hemispheres may be engaged in processing verbal data; that is, the left hemisphere is involved in analyzing the meaning, while the right hemisphere places meaning in context. In addition, the left hemisphere is receptive to details, while the RH is responsive to general patterns. The hemispheres are different not because they process different types of stimuli, but because they process the same information in different ways.

Age and Sex Factors

Concerning age of acquisition, Anderson et al. (1985) suggested that second language learning requires different strategies of processing at different stages. When the learner is young, left hemisphere strategies have a tendency to dominate, but later, due to decreased plasticity and advanced paralinguistic skills, right hemisphere strategies are preferred.

On the other hand, Anderson et al. concluded that there was no supporting evidence that greater right hemisphere involvement takes place in SLA due to age and sex. However, adolescent learners used more processing resources in their first and second languages, maybe because they were less fluent and exerted greater effort in general language learning. Females, moreover, showed more responsiveness in their right hemispheres during language processing.

The authors concluded that the second language teacher should provide "naturalistic, conversational settings that are highly redundant and have rich contexts" (p. 22). In that way, the teacher can strengthen involvement of the right hemisphere.

Neuronal Involvement in First and Second Language Acquisition

Jacobs (1988) discusses neurobiological evidence that learning a first language is different from learning a second language. Primary language acquisition (PLA) is concurrent with the development of the nervous system; it is dependent on and accountable for maturational neuronal changes. When second language is acquired, it must be merged into a neuronal structure already established by Universal Grammar (UG) and PLA interaction. Since the brain is not able to reproduce neurons after birth, the integration entails changing the existing substrate as well as using the same and/or different structures. As the primary language is continually used and polished, it becomes more automatic and requires smaller areas of the brain, therefore freeing cortical areas for SLA. This view suggests that the earlier second language acquisition begins, the greater is the advantage of brain plasticity. In addition, the second language appears to be more widely represented in the brain than is the primary language, so there is a suggestion that people who are bilateral can acquire an exceptional level of SLA.

Thus, from Jacobs' point of view, PLA and SLA take place through quantitatively different neurobiological mechanisms. Nevertheless, it is possible that the second language learner can achieve native-like competence, because dif-

ferent neural organizations can produce similar behaviors. Since an existing functional substrate in the adult needs only to be adjusted, rather than newly developed, reduced plasticity may not be as difficult an obstacle to SLA as is often believed.

Accordingly, fossilization need not be permanent, because all environmental factors can influence the neural substrate.

> Even though the adult brain cannot undergo the radical changes that develop the brain, the adult brain certainly remains plastic, capable of adapting extant substrate to new challenges such as the learning of a second language. [p. 327]

As Jacob points out, by age five the child has been actively involved in PLA for about 9,100 hours, which is much more than the average second language learners would spend on their language learning tasks.

Lateralization versus Modularity

In another approach, Munsell, Rauen, and Kinjo (1988) viewed the brain as highly modular; that is, it has a great many independent, specialized modules working rather loosely together, and some of these modules are specific to language acquisition. The language teacher can facilitate a learner's success by providing instructions that target the specific language-specific modules.

According to Munsell et al., conscious processes cannot be isolated from unconscious ones. There is a continuum between conscious and unconscious processes. This notion suggests that the teacher provide various activities—analysis, intuitive insight, work, and play—in order to give a balance and variety of the mental processes.

Modularity is much more important than laterality, according to these authors. The brain has hemispheric specialization, but its pedagogical implications are rather insignificant. Language learning should provide abundant, diverse activities, so that individuals can choose the types of processes that suit them. This approach may encourage those who normally rely on one type of thinking pattern to try different modalities.

Munsell et al. adopt Gardner's (1983, 1985) six types of intelligence: linguistic, musical, logical-mathematical, spatial, kinesthetic, and personal. To accommodate these intelligences, the teacher should provide a variety of activities.

Memory, however, remains a puzzle. The brain has many different types of memory in numerous locations of the cortex. In addition, one's memory seems to consolidate while one sleeps. Perhaps more dreamable materials should be made available to language learners.

Neurolinguistic Accounts of Bilingualism

Grosjean (1989) discusses holistic/bilingual views of bilingualism. In the holistic view, bilingual ability is considered as an integrated whole, not as the simple sum of two monolingual abilities. Bilinguals use their two languages for different purposes in different environments and with different targets. Fluency in

one language relies on the needs created by the environment, and since the needs of the two languages are different, bilinguals do not develop equal fluency in both languages. By examining the various speech modes of the bilingual and identifying "deficits" in the modes, it may be possible to gain a better understanding of bilingual aphasia and the neurolinguistics of bilingualism.

In 1990, Paradis argued that research comparing unilinguals and bilinguals reported no significant differences in lateralization, and those differences that did exist were contradictory. Paradis went on to suggest that neuropsychologists should redirect their attention to more productive research. Not only did he doubt the argument that the right hemisphere is involved in both languages of bilinguals, he also contended that the current speculations were based on unreliable research and that there was no clinical evidence that the use of the right hemisphere was more dominant in bilinguals than in unilinguals.

The Critical Period and Lateralization

Danesi (1994) examined primary versus secondary language acquisition, the critical period hypothesis, and the role of the right hemisphere. It is his contention that the significant neuroscientific study of SLA began in the 1970s when Krashen reevaluated Lenneberg's clinical data (Krashen, 1973) and observed that PLA took place before age six. Moreover, Danesi disagreed with Lamendella (1977), who argued that PLA and SLA are dichotomous: they use different neurofunctional systems. Danesi argued that there was no evidence that different cerebral systems exist for PLA and SLA before or after the critical period. Currently, neuroscientists widely share the Paradis-Perecman view that bilinguals have the same conceptual systems as monolinguals, but that they have two independent semantic systems. Thus, the issue of reorganization of brain structure because of language learning after the PLA is inconclusive.

Lenneberg's critical period hypothesis remains inconclusive. In 1988, Scovel conducted comprehensive research on the hypothesis and concluded that there was no clear evidence that biological restrictions exist in language acquisition, except for the acquisition of pronunciation. More significant are psychological aspects such as motivation and cognitive style. Another view is that of Selinger (1978) and Walsh and Diller (1981), who suggested the existence of various critical periods for different subsystems of language. Finally, the theory of Universal Grammar does not acknowledge the possibility that SLA will ever reach the level of PLA. Danesi, however, believes that this UG view, which assumes that adults have only limited "accessibility" to language universals, is too narrow, because the adult learner has other resources besides biology, such as experience and training.

BIMODALITY

According to Danesi and Mollica (1988), bimodality is an educational construct that provides a theoretical foundation for second language instructions in the class-

room. It posits that in language acquisition "there is a natural flow from the synthetic and contextualizing functions of the right hemisphere to the analytical and formalizing functions of the left one" (p. 77) and both hemispheres play pivotal roles in successful language learning.

Danesi (1987) adopted Edwards' terminology, L-Mode and R-Mode, to refer to modalities of the hemispheres. The L-Mode features include "most speech functions, deciphering meaning, verbal memory, intellectual tasks, abstacting, and analytical, linear thinking," and R-mode features are "understanding figurative language and visual relations, spatial memory, intuitive tasks, free thinking, and relational, multiple, and synthetic thinking" (p. 380). The two hemispheres process language input as a unit and are thus complementary: the left hemisphere enables us to analyze individual concepts, while the right hemisphere allows us to synthesize information into discourse. Anatomically proven is that the right hemisphere is actively involved in initial learning tasks, and this fact suggests that the right hemisphere is more adept at processing new material. The left hemisphere, on the other hand, depends on previously processed information.

As for its classroom implications, bimodality suggests five instructional principles: modal directionality, modal focusing, creativity, contextualization, and personalization, as follows:

Modal directionality: Modal directionality is related to the initial tasks of language learning. Since the right hemisphere is better equipped to perform these tasks, teaching should reflect this fact by supplying concrete forms of instruction in the initial stages of learning.

Modal focusing: The principle of modal focusing means that, once the new concept is processed in the R-Mode, the learning process should shift to the L-Mode for analysis and organization.

Creativity: Creativity pertains to the ability of the learner to utilize language in creative and expressive ways.

Contextualization: When the learning task is L-Mode, supporting contexts should be provided in a process called contextualization. Among contextualization techniques are the use of open dialogues, authentic texts, and realia. Through these techniques grammar can be taught in context.

Personalization: Personalization activities, such as role-playing and diary-keeping, engage the student in "interactional" tasks that utilize a right-hemisphere function and provide context.

These principles highlight the fact that bimodality is not a "method," but a teaching construct. In his review of early language teaching methods, Danesi (1988) surveyed–from the perspective of bimodality–the failures of various language teaching methods and the subsequent abandonment of the method notion in the 1960s and

1970s. All of the early methods relied on inductive and deductive processes: the grammar-translation approach in the nineteenth century, the direct method from the second half of the nineteenth century to the end of World War I, the reading method of the 1920s and 1930s, and the audiolingual method up to the late 1960s. Consequently, the methods focused on left-hemisphere functions. Because they were unimodal, Danesi's concept of bimodality offers an neurological explanation for their failures.

More recent methods have fared little better in Danesi's view. The cognitive teaching method in the late 1960s and early 1970s attempted to revive deductive language teaching, but, as an L-Mode-focused approach, it was also unimodal and therefore short-lived. Then, in the 1970s, the concept of communicative competence replaced the method notion, but it too was limited in that it had the opposite tendency of utilizing the R-Mode while disregarding the L-Mode functions. Finally, in the 1980's, there were attempts to coordinate the grammatical (L-Mode) and communicative (R-Mode) approaches, and Danesi predicted that this integrated approach would receive the focus in the following decade.

In 1988, Danesi and Mollica conducted a pilot study on bimodality. An experimental group was given bimodal instructions (BM group) and two control groups were given instructions with L-Mode-dominant techniques (LM group) and R-Mode-dominant techniques (RM group), respectively. The subjects were first-year students enrolled in a beginning-Italian course for nonnative speakers at the University of Toronto. The LM group was provided with materials that focused on formalistic techniques such as the use of rules and mechanical drills, while the RM group was given materials that emphasized communicative tasks. The BM group was supplied with new material presented in the R-Mode, and the students were allowed to contribute "creative input" by using discourse techniques; in this way their backgrounds and interests were reflected in classroom practices.

When the students' overall achievement was compared, the BM group showed proficiency across the skills tested. Their performance was equal to the LM group in L-Mode skills (a fill-in-the-blank section of a two-hour test) and the RM group in R-Mode skills (a dialogue-expectancy section), but the BM group performed better than the other two groups both on the global proficiency (a cloze section) and on creative components (a 150-word composition).

Danesi (1991) reports on a follow-up study performed one year after the pilot study. Since in his pilot study Danesi had a problem in classifying teaching techniques into R-Mode or L-Mode without a neuroscientific basis, he used Lateral Eye Movement (LEM) to validate the modal categories used in the pilot study. In most right-handed people, when the left-hemispheric functions are activated, their eyes move slightly to the right, while right-hemispheric functions cause the eyes to move leftward. Three sub-

jects were given six ten-minute lessons for three days, and at the end of each session, while the subjects were thinking about the lesson, their eye movements were recorded with a video camera. The results allowed Danesi to validate the modal categories of the pilot study as neuroscientific terms.

In another study, Pallotta (1993) examined, from the perspective of bimodality, the five working hypotheses for proficiency-oriented instruction developed by Omaggio (1986) as follows:

1. *"Opportunities must be provided for students to practice using language in a range of contexts likely to be encountered in the target culture"* (p. 44).
   As noted before, contextualization is certainly an important part of Danesi's bimodal concept of instruction and one of his pedagogical principles.

2. *"Opportunities should be provided for students to practice carrying out a range of functions likely to be necessary in dealing with others in the target culture"* (p. 48).
   Performing tasks in real-life or simulated contexts involves the right hemisphere functions, while the left hemisphere is engaged in processing the grammatical structures necessary to carry out the tasks. This involvement of both hemispheres characterizes bimodal instruction.

3. *"In proficiency-oriented methods there is a concern for the development of linguistic accuracy from the beginning of instruction"* (p. 48).
   Proficiency-oriented instruction monitors the learner's linguistic output and provides necessary feedback. In this way, the left hemisphere is activated while right-hemispheric activities are being performed.

4. *"Proficiency-oriented methodologies respond to the affective needs of students as well as to their cognitive needs"* (p. 52).
   The implication of this statement is that language teaching involves the whole brain.

5. *"Proficiency-oriented methodologies promote cultural understanding and prepare students to live more harmoniously in the target-language community"* (p. 53).
   Both cultural understanding and harmonious living involve both hemispheres. The left hemisphere processes cultural information, but involvement of the right hemisphere is also required because the data can be fully understood only in a context evolving from one's experiences.

Thus, Omaggio's principles represent a close parallel to Danesi's bimodality.

DISCUSSION AND CONCLUSIONS

In a rare attempt to apply research data in neuroscience to the field of second language teaching, Danesi proposed bimodality as a theoretical basis for instructional practices in the classroom. Bimodality is based on the neurobiological observation that the right hemisphere is anatomically disposed to process new stimuli more efficiently than the left. The reason for this difference is that the right hemisphere has greater interregional connectivity in the cortex, while the left hemisphere has a sequential neural structure. The left hemisphere, therefore, better at processing information for which pre-existing data is available. Bimodality postulates that there is a flow in cognitive processing during language acquisition from "the intuitive, synthetic, and contextualizing functions" of the right hemisphere to "the analytical and formalizing functions" of the left hemisphere (Danesi, 1987, p. 380), and therefore second language teaching should reflect that flow.

The bimodality hypothesis raises certain unresolved issues. Although the right hemisphere is considered to play an important role in second language learning, and Danesi's bimodality is based on such data, the evidence for the role of the right hemisphere in SLA is nevertheless inconsistent. Danesi and Mollica (1988) admit that the evidence for the importance of the right hemisphere in the early stages of second language acquisition is contradictory.

Moreover, Paradis (1990) argues that there is no evidence that the right hemisphere is used more predominantly by bilinguals than by unilinguals and in fact doubts that the right hemisphere plays any significant role in language learning. That author further suggests that the right hemisphere may actually obstruct acquisition of native-like fluency. In his 1994 review paper, Danesi agrees with Paradis' view that there is no clear evidence for the participation of the right hemisphere in the organization of language in SLA. Danesi acknowledges that any attempt to interpret technical neuroscientific findings into instructionally feasible concepts is risky and must be done "cautiously and judiciously" (p. 221). Perhaps the contradictory evidence and Danesi's dilemma are best reflected in Munsell, Rauen, and Kinjo's observation (1988): "The brain is exceedingly complex and easily leads to categorical generalizations on the basis of limited evidence. No one knows enough in our opinion to offer a neurolinguistic approach to language learning or to any type of learning" (p. 261).

Another issue concerning Danesi's bimodality is the lack of empirical studies. As previously discussed, Danesi and Mollica (1987) conducted a pilot study on bimodality as a hypothesis, and Danesi (1988) was a follow-up study; the LEM method in the follow-up study has too many constraints to be considered a valid method for an experimental study. Both studies, moreover, used small groups of subjects, so that their outcomes are statistically insignificant. To establish bimodality as a practical concept, additional empirical studies must be performed with different types of subjects, ma-

terials, and instructor styles in different classroom settings. Only when a consistent pattern of significant results is available can bimodality be considered worthy as a theoretical basis for instructional practice.

The final issue is that Danesi's bimodality hypothesis has possibly been the only concrete proposal for second language teaching from the perspective of neuroscience. Consequently, there have been few arguments for or against it from other SLA researchers. Thus, the validity of the hypothesis requires additional research and the support of appropriate neuroscientific data.

IMPLICATIONS FOR TEACHING

If bimodality is established as a valid, workable concept, its implications for second language teaching would be extensive. First, language teaching should reflect the natural right-to-left flow from concrete to more formal forms of instruction. The R-Mode operates better in initial-orientation tasks or until sufficient sensory information has been absorbed. After the right hemisphere has processed the new stimuli, the left hemisphere takes over the processing. Therefore, instructions should start with concrete and sensorial presentation techniques and then should shift to formal, mechanical instructional procedures.

Second, a variety of activities in classroom should be emphasized. Bimodality suggests that the modalities of both hemispheres are essential to the classroom situation. Consequently, the teacher should select a rich diversity of activities that consistently stimulate the two learning modes. Munsell et al. (1988) noted that individual learners should be able to choose the types of learning processes that suit them, in which case a diversity of instructional practices becomes even more important.

Third, there must be provision in instruction for L-Mode learning. Recently, there has been heavy emphasis on communicative competence in SLA, which exercises the right hemisphere. As stated above, however, the bimodality construct suggests that learners shift to the L-Mode learning after the initial processing stages. For that reason, a viable teaching approach still requires techniques such as dictation, reading, writing, and examination of grammar. If we do away with all forms of pattern practice from the classroom, the left, or verbal, hemisphere will be deprived of the opportunity to analyze and organize the language data processed by the initial R-Mode functions.

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